

August 5, 1994

CD-94-16 (LDV/LDT/SM/ICI/LIMO)

Dear Manufacturer,

Subject: Protocol for MPG Calculations for Vehicles Tested on
Phase II Gasoline

The purpose of this letter is to provide manufacturers and other interested parties with EPA's current position on calculating fuel economy (mpg) values for vehicles tested on California phase II gasoline. The method of calculating city and highway mpg values contained in 40 CFR 600.113-88 is not applicable to phase II test fuel and other oxygenated fuels. For this reason, EPA is providing a method to calculate the mpg values for vehicles tested on phase II fuel. The calculation method contained in Enclosure I is being provided in DRAFT form to allow manufacturers and other interested parties an opportunity to comment on it before it becomes final. Please send your written comments to Mr. Dave Good on or before September 15, 1994. In addition, EPA will require any previously submitted phase II fuel economy data to be recalculated using a calculation procedure applicable to phase II fuel.

The provisions of 40 CFR 600.113-88 require fuel economy values to be based on vehicles tested on EPA certification test fuel, however manufacturers have expressed a desire to optionally use the fuel economy values generated during California certification testing (using California Phase II test fuel) to avoid the extra burden of retesting these vehicles with EPA test fuel. EPA's general policy in this matter is contained in Advisory Circular (A/C) 83A, paragraph E.2.a., which states:

"EPA will grant test vehicle substitutions in situations where the test vehicle was tested in a different test condition and the fuel economy of the test condition not tested would be expected to be higher for both the EPA city and highway test (i.e., worst-case data were

generated)."

Data available to EPA indicate that the energy content (in BTU/gallon) of California phase II test fuel is approximately 2-3 percent lower than that of EPA certification test fuel. Lower energy content should result in "worst case" fuel economy data. Therefore, EPA is proposing to allow the use of this data at the manufacturers option, provided the mpg values are calculated

according to the method contained in Enclosure I, or another method acceptable to EPA. The Agency intends to allow the use of this data under the policy outlined in A/C 83A, as an interim measure until the regulations can be updated in a future rulemaking.

Comments are requested on the DRAFT "EPA Recommended Procedure For Calculating Fuel Economy (MPG) Values For Vehicles Tested On California Phase II Gasoline" contained in Enclosure I. The DRAFT method uses FID hydrocarbon analysis, and does not require that the exhaust gas sample be analyzed for alcohols, ethers, and other oxygenated HC compounds. It is similar to EPA's procedure for calculating mpg values for methanol-fueled vehicles, as contained in the Final Rule for Fuel Economy Test Procedures, Alternative-Fueled Automobile CAFE Incentives and Fuel Economy Labeling Requirements, ref. 59 FR 39638, August 3, 1994.

For vehicles tested on California phase II test fuel, EPA is proposing to report the fuel economy values for the city and highway tests calculated according to the method contained in Enclosure I, and treat these mpg values as the "official" fuel economy values for the vehicle. The Agency believes that the error due to not performing wet chemistry and gas chromatographic analysis of the oxygenated, exhaust HC compounds will be much smaller than the fuel economy penalty associated with the optional use of the Phase II test data. The DRAFT method uses a factor, $[1.1 \times \text{HC}]$, in both the dilution factor and the mpg calculations to compensate for not performing wet chemistry and gas chromatographic analysis. This 1.1 factor is based on a "worst case" assumption that the mass of the unmeasured, oxygenated, exhaust gas HC compounds are present in the exhaust gas in the same proportion as the mass of MTBE in the fuel.

Effective immediately, based on the provisions of 40 CFR 86.090-27(b), manufacturers should not use the method contained in 40 CFR 600.113-88 to calculate the fuel economy (mpg) values of vehicles tested on California Phase II gasoline, because this method is not appropriate for vehicles tested on oxygenated fuels. For example, the provisions of 40 CFR 600.113-88 require the carbon weight fraction of the fuel to be determined using ASTM procedure D 3343 and the net heating value of the fuel (in BTU/lb) to be determined using ASTM procedure 3338. Neither of these ASTM procedures are appropriate for California Phase II (oxygenated) fuel. If manufacturers have used the method contained in 40 CFR 600.113-88 to calculate the mpg values for previous phase II tests, they

should either retest the vehicle using EPA certification test fuel; or contact their certification team representative with a proposal to properly calculate the mpg values for the vehicle under the provisions of 40 CFR 86.085-27(a) "Special Test Procedures."

If you have any questions about this letter, please contact Dave Good on (313) 668-4450.

Sincerely,

Robert E. Maxwell, Director
Certification Division
Office of Mobile Sources

Enclosure

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DRAFT

Enclosure I

**EPA Recommended Procedure For Calculating Fuel Economy (MPG)
Values For Vehicles Tested On California Phase II Gasoline**

The following procedure is intended to be used to determine the approximate fuel economy (mpg) values for vehicles tested on CARB phase II gasoline, since exhaust hydrocarbon emissions are based on FID total HC measurements, only.

(a) Calculate the weighted grams/mile values for the city fuel economy test for HC, CO, and CO₂ as specified in §86.144, except that the dilution factor shall be calculated as follows:

$$\text{Dilution Factor} = \frac{100 * (x) / (x + y/2 + 3.76(x + y/4 - z/2))}{\text{CO}_{2e} + (1.1 * \text{HC}_e + \text{CO}_e) * 10^{-4}}$$

where:

Fuel composition is C_xH_yO_z as measured for the fuel used.

Measure and record the test fuel's properties as specified in paragraph (c) below.

(b)(1) Calculate the mass values for the highway fuel economy test for HC, CO, and CO₂, as specified in §86.144(b), except that the dilution factor shall be calculated as follows:

$$\text{Dilution Factor} = \frac{100 * (x) / (x + y/2 + 3.76(x + y/4 - z/2))}{\text{CO}_{2e} + (1.1 * \text{HC}_e + \text{CO}_e) * 10^{-4}}$$

where:

Fuel composition is C_xH_yO_z as measured for the fuel used.

Measure and record the test fuel's properties as specified in paragraph (c) below.

(2) Calculate the grams/mile values for the highway fuel economy test for HC, CO, and CO₂, by dividing the mass values obtained in paragraph (b)(1) of this section, by the actual distance traveled, measured in miles, as specified in §86.135(h).

(c)(1) Phase II test fuel shall be analyzed to determine the following fuel properties:

(i) Determine the specific gravity of the Phase II fuel using either:

(A) ASTM D 1298 for the blend, or

(B) ASTM D 1298 for the gasoline fuel component and the theoretical specific gravity of the MTBE fuel component; and combining as follows:

$$SG = SG_g \times \text{volume fraction gasoline} + .7405 \times \text{volume fract MTBE}.$$

where:

SG_g = Specific gravity of gasoline as measured by ASTM D 1298
.7405 = the theoretical specific gravity of MTBE.

(ii) Determine the carbon weight fraction of the Phase II fuel using the following equation:

$$CWF = CWF_g \times MF_g + 0.681 \times MF_{mtbe}$$

where:

CWF_g = Carbon weight fraction of gasoline portion of blend per ASTM D 3343.

0.681 = Carbon weight fraction of MTBE.

MF_g = Mass fraction gasoline = $(G \times SG_g) / (G \times SG_g + .7405 \times \text{MTBE})$

MF_{mtbe} = Mass fraction MTBE = $(.7405 \times \text{MTBE}) / (G \times SG_g + .7405 \times \text{MTBE})$

where:

G = Volume fraction gasoline

MTBE = Volume fraction MTBE

SG_g = Specific gravity of gasoline as measured by ASTM D 1298

.7405 = the theoretical specific gravity of MTBE.

With prior approval of the Administrator, other procedures to measure the carbon weight fraction of the fuel blend may be used if the manufacturer can show that the procedures are superior to or equally as accurate as those specified in this paragraph.

(d) Calculate the city and highway fuel economy from the grams/mile values for HC, CO, CO₂, and, the test fuel's specific gravity, and carbon weight fraction. The emission values (obtained per paragraph (a) or (b) of this section, as applicable) used in each calculation of this section shall be

rounded in accordance with §86.084-26(a)(6)(iii). The CO₂ values (obtained per paragraph (a) or (b) of this section, as applicable) used in each calculation of this section shall be rounded to the nearest gram/mile. The specific gravity and the carbon weight fraction (obtained per paragraph (c) of this section) shall be recorded using three places to the right of the decimal point. These numbers shall be rounded in accordance with the "Rounding Off Method" specified in ASTM E 29-67.

(e) For vehicles tested on Phase II gasoline, the fuel economy in miles per gallon is to be calculated using the following equation:

$$\text{mpg} = (\text{CWF} \times \text{SG} \times 3781.8) / ((1.1 \times \text{CWF}_{\text{exHC}} \times \text{HC}) + (0.429 \times \text{CO}) + (0.273 \times \text{CO}_2))$$

Where:

CWF = Carbon weight fraction of the fuel as determined in paragraph (c)(1)(ii).

SG = Specific gravity of the fuel as determined in paragraph (c)(1)(i).

3781.8 = a constant equal to 3785.412 g/gal x 0.99904 (the density of water at 60°F, ref. ASTM D 4052).

1.1 = a constant based on the mass proportion of gasoline in the California phase II test fuel.

CWF_{exHC} = Carbon weight fraction of exhaust hydrocarbons which is assumed to be equal to CWF_g as determined in paragraph (c)(1)(ii).

HC = Grams/mile HC as obtained in paragraph (d).

CO = Grams/mile CO as obtained in paragraph (d).

CO₂ = Grams/mile CO₂ as obtained in paragraph (d).

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